Forest Service National Remote Sensing Program and Geospatial Technology and Applications Center Update

NASA Wildfire Applications Review Meeting

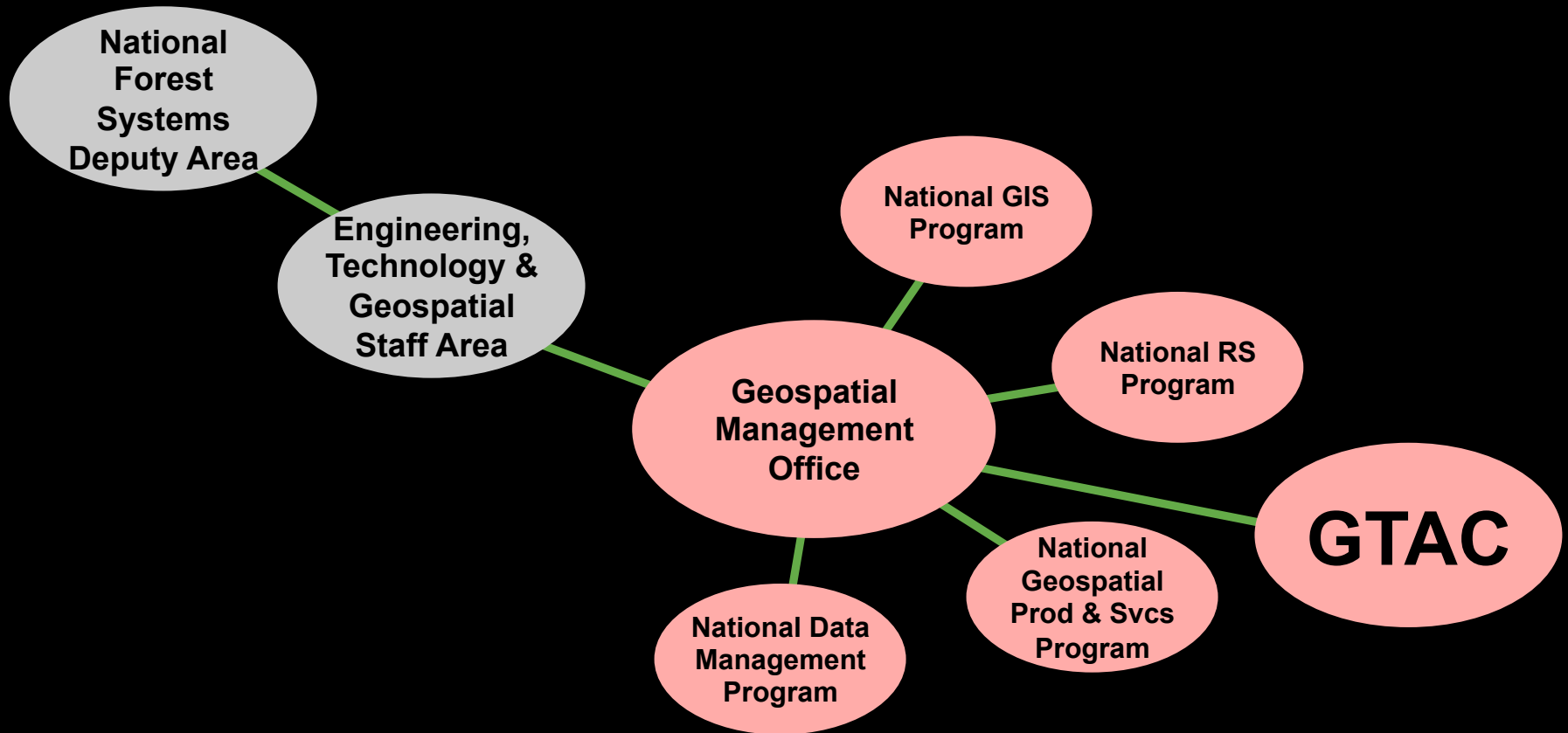Boulder, Colorado

February 28 – March 2, 2017

Geospatial Technology and Applications Center (GTAC)

Organizational Structure

National Forest Systems Deputy Area

Engineering, Technology & Geospatial Staff Area

Geospatial Management Office

National GIS Program

National RS Program

GTAC

National Geospatial Prod & Svcs Program

National Data Management Program

NOTE: The Geospatial Technology Applications Center (GTAC) was formed through the integration of the Geospatial Service and Technology Center (GSTC) and the Remote Sensing Applications Center (RSAC), and is an organizational component of the Geospatial Management Office (GMO).

The National Remote Sensing Program

The National Remote Sensing Program provides subject matter expertise to a wide range of agency business areas <u>including</u>; Engineering, Fire & Aviation Management, Forest Health Protection, Research and Law Enforcement & Investigations.

The position provides remote sensing leadership and direction to the Geospatial Management Office (GMO) Program Managers, Forest Service regions and field units, and the Geospatial Technology Application Center.

Interagency Forums

Tactical Fire Remote Sensing Advisory Committee (TFRSAC)

The TFRSAC is a civil interagency committee which facilitates the evaluation and transfer of remote sensing technology for wildland fire applications. This TFRSAC core committee consists of the USFS and NASA stakeholders who collaboratively guide the research and demonstration directions of the science team. Partners on this committee participate in twice yearly committee meeting to coordinate and facilitate technology transfer elements as they relate to fire imaging, data ingestion, data processing, and data and information decision support system integration and utility.

Next meeting: May 2017 (date TBD) / NASA Ames Research Center

Interagency Forums

Thermal Working Group (TWG)

- Provide a working-level forum that focuses on marketing and awareness of thermal detection and reporting capabilities of the IC and Civil communities.

- Provide advocacy, oversight and prioritization of capability needs, end-to-end readiness activities of future capabilities and assist with enabling technology insertion.

- Document civil community requirements for the receipt of IC-produced products.

- Coordinate on the capability evolution of systems with research and development (R&D) and acquisition.

- Coordinate the appropriate policy approvals to ensure timely dissemination to Civil consumers of IC-produced products.

- Provide a forum that will elicit and provide customer feedback.

- Facilitate the coordination and operationalization of civil applications of IC-provided capabilities.

Last meeting: Thermal Summit / Feb 2017 / SAIC in Chantilly VA
Next meeting: Occur every 2 years or earlier as needed

Interagency Forums

The goal of these interagency forums is to advance the use of remote sensing technology in the wildland fire arena in a reliable way in order to:

1. Support decision support for all phases of fire (useful tactical intelligence), and

2. Provide actionable intelligence in a timely manner to keep the fire fighters safe, to keep the public safe, and to protect assets at risk and to protect our natural resources.

GTAC Disturbance Assessment and Services (DAS) Program Support

Wildfire Management Phase	Functions	Programmatic Activities
Preparedness	Fire intelligence and fire risk assessment	National Interagency Coordination Center Support
		Predictive Services Program Support
Detection and Response	Strategic and tactical fire detection, monitoring & mapping	Tactical Fire Mapping (NIROPS) Support
		UAS Technology Evaluation/ Integration
		Active Fire Mapping/Satellite DR Operations
Post-Fire Assessment	Burn severity mapping & characterization	Burned Area Emergency Response (BAER) Support
		Reforestation Planning & Prioritization Support
		Monitoring Trends in Burn Severity (MTBS)

Tactical Fire Mapping Support

(https://fsapps.nwcg.gov/nirops)

- "NIROPS" - National Infrared Operations Unit

- Provides daily high resolution airborne IR imaging

- Facilitates fire detection/mapping products to support incident command operations
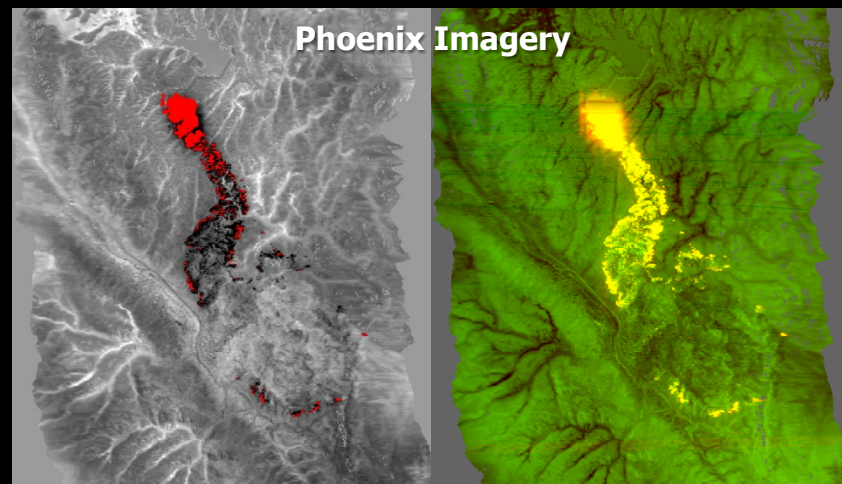

GTAC Support Functions:

- Maintenance
  - NIROPS website
  - IR ordering system
  - Operations Users Guide
  - IR Vendor listing
- Phoenix sensor tech support
- Technology evaluation
- IRIN incident support
- IRIN training

Tactical Fire Mapping Support

Typical NIROPS Workflow

- Phoenix imagery acquired by two agency aircraft

- Ortho-imagery delivered via AirCell for immediate access by IRINs

- Suite of high resolution, daily fire products provided to IMTs

  - Shapefiles, KMZs, maps

- Products inform incident management decisions for upcoming operational period

Phoenix Imagery

144Z Cessna Citation Bravo II

149Z Beechcraft Super King Air 200

Fire Map Product

Las Conchas Fire
Infrared Heat Sources, 6/27/2011 0309 hrs

Legend
- Heat Perimeter
- Intense Heat
- Scattered Heat
- Isolated Heat Source

Tactical Fire Mapping Support Updates

1,495 nationwide requests filled by NIROPS in CY2016

144Z Cessna Citation Bravo II

N149Z
May thru 1st week
Oct 2016

149Z Beechcraft Super King Air 200
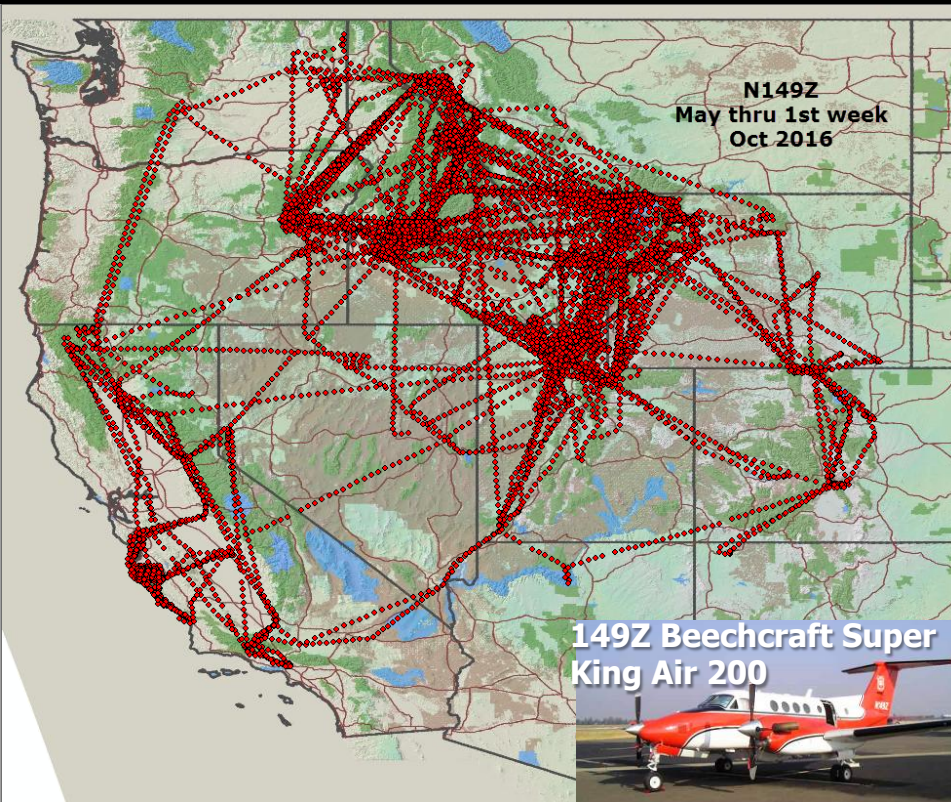
Western U.S. missions by 144Z and 149Z through 1st week of Oct 2016

Tactical Fire Mapping Support Updates

- ## Autonomous Modular Sensor (AMS)

  - Hardware updates and testing ongoing

  - OBP and PMP system developments, refinements and integration ongoing

  - 2017 FS testing/integration missions possible, but not anticipated

  - Anticipate readiness for 2018 fire science campaigns

    - Fire and Smoke Model Evaluation Experiment (FASMEE), etc.

AMS Wildfire Sensor

Two environmental enclosures (data disks & GPS; and power supplies & controllers)

Data System Enclosure
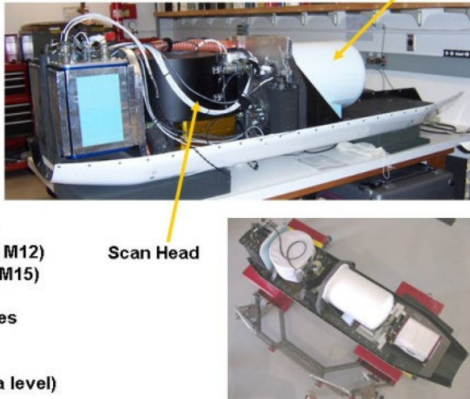
Band	Wavelength μm	
1	0.42- 0.45	
2	0.45- 0.52	(TM1)
3	0.52- 0.60	(TM2)
4	0.60- 0.62	
5	0.63- 0.69	(TM3)
6	0.69- 0.75	
7	0.76- 0.90	(TM4)
8	0.91- 1.05	
9	1.55- 1.75	(TM5)
10	2.08- 2.35	(TM7)
11	3.60- 3.79	(VIIRS M12)
12	10.26-11.26	(VIIRS M15)

Scan Head

Total Field of View:	85.9 degrees
IFOV:	2.5mrad
Altitude:	25000'
Spatial Resolution:	20m (at sea level)
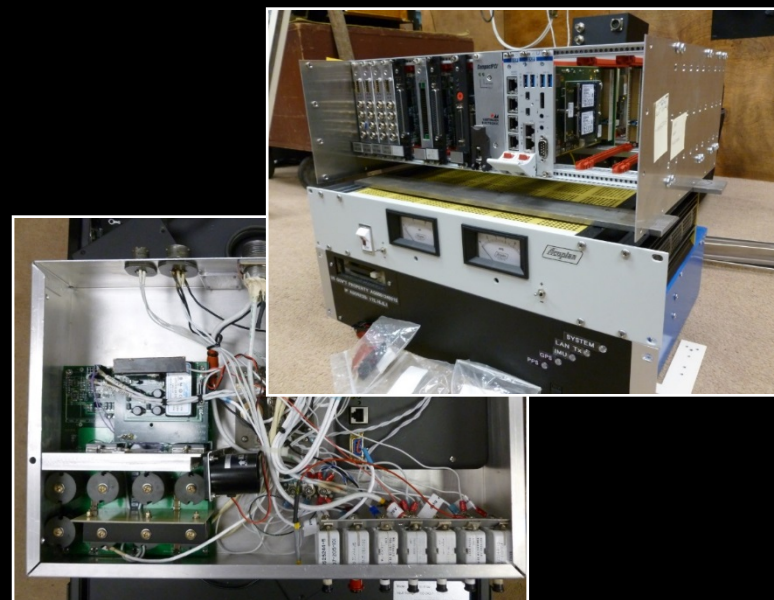
2016 Planned Forest Service UAS Missions

1. North Fire Support / Cibola NF (June)

2. Eurasian Milfoil Mapping / Fishlake NF (September)

3. FHP/FM Aerial Survey / Apache-Sitgreaves NF (September)

4. Blackjack/Bluebird Mine Aerial Survey / Umatilla NF (October)

5. Champion Mine Aerial Survey / Umpqua NF (October, postponed)

6. Pioneer Fire Post-Fire Aerial Survey / Boise NF (October, postponed)
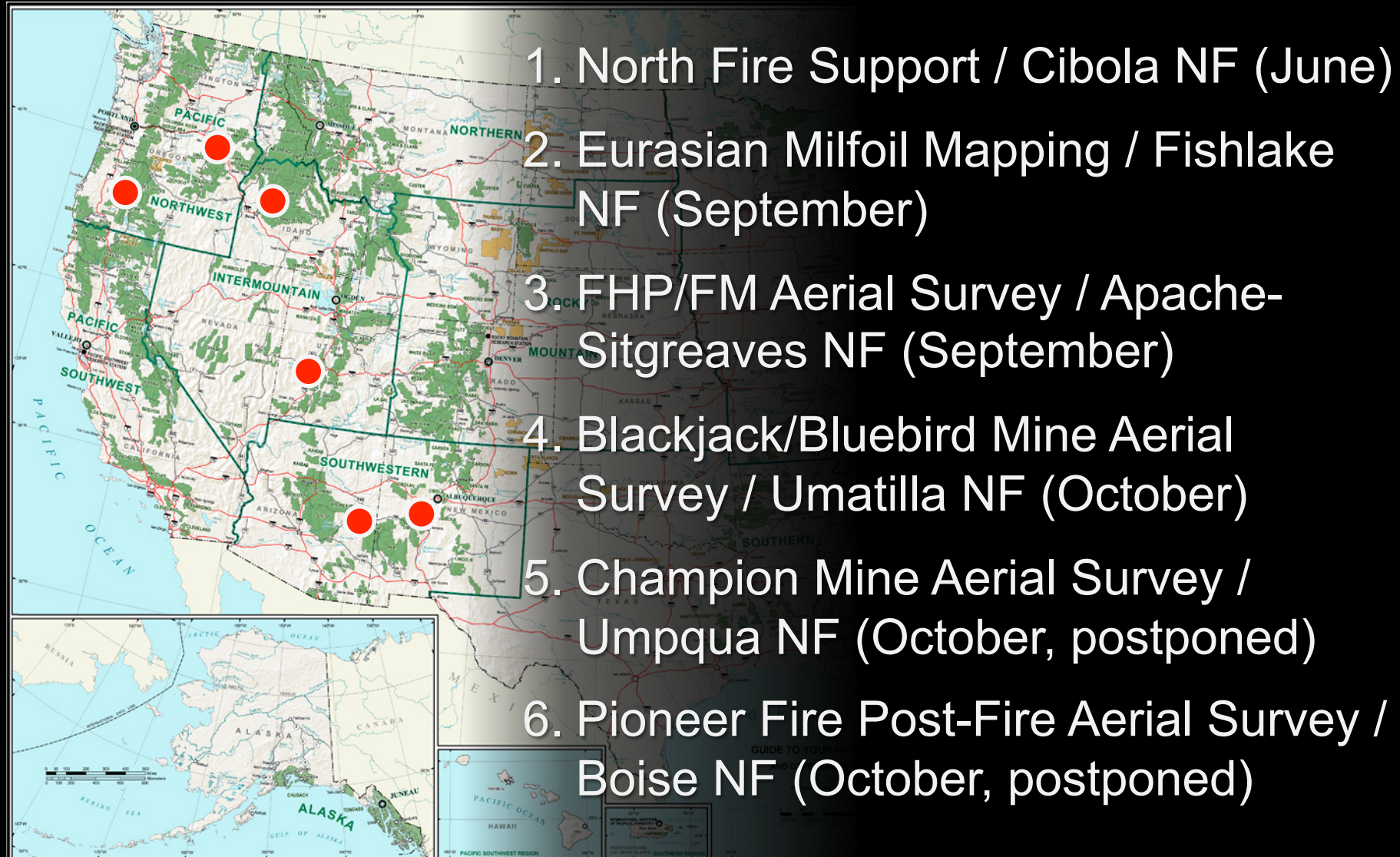
FHP/FM Aerial Survey Mission

- Location: Hannagan Meadow (Apache-Sitgreaves NF)

- Project Area: 200 acres

- Objective(s):

  - Acquire high resolution (2 inch) multispectral imagery

  - Evaluate use of imagery and derivative products to cost effectively:

    - Detect and monitor outbreaks of native and/or exotic forest pests

    - Estimate forest biomass parameters

  - Evaluate contracting for UAS and use of UAS within FS aviation system

- Mission Date(s): September 12-15, 2016

- Mission Type: Contracted
  - Ryka UAS Services (FAA 333 exemption)

1,500 Feet

2013 NAIP
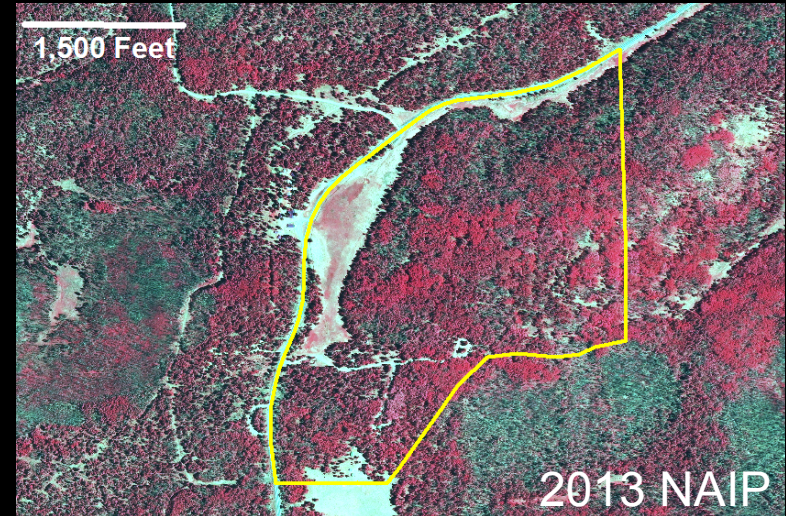
FHP/FM Aerial Survey Mission

Platform

Matrix Turbo Ace Quad Copter

- Power: Electric
- Size: 39.3" x 15.5"
- Weight: 3.5 lbs
- Payload Weight 5 lbs
- Endurance: 15-45 minutes
- Speed: 60 mph

Sensor Payload

RGB/Near Infrared Camera

- MicaSense Red Edge
- Spectral Response: 0.4µm – 0.85µm
- Resolution: 3" at 400' altitude

FHP/FM Aerial Survey Mission

FHP/FM Aerial Survey Mission

Natural color frame
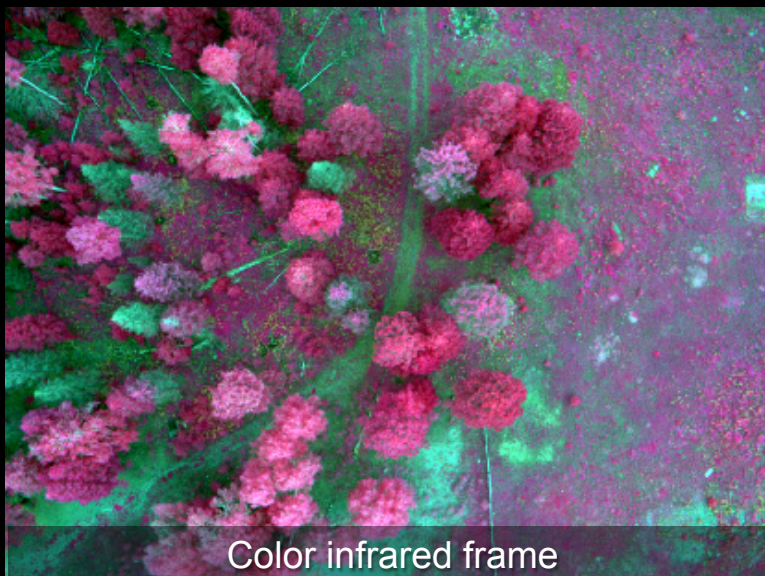

Color infrared frame
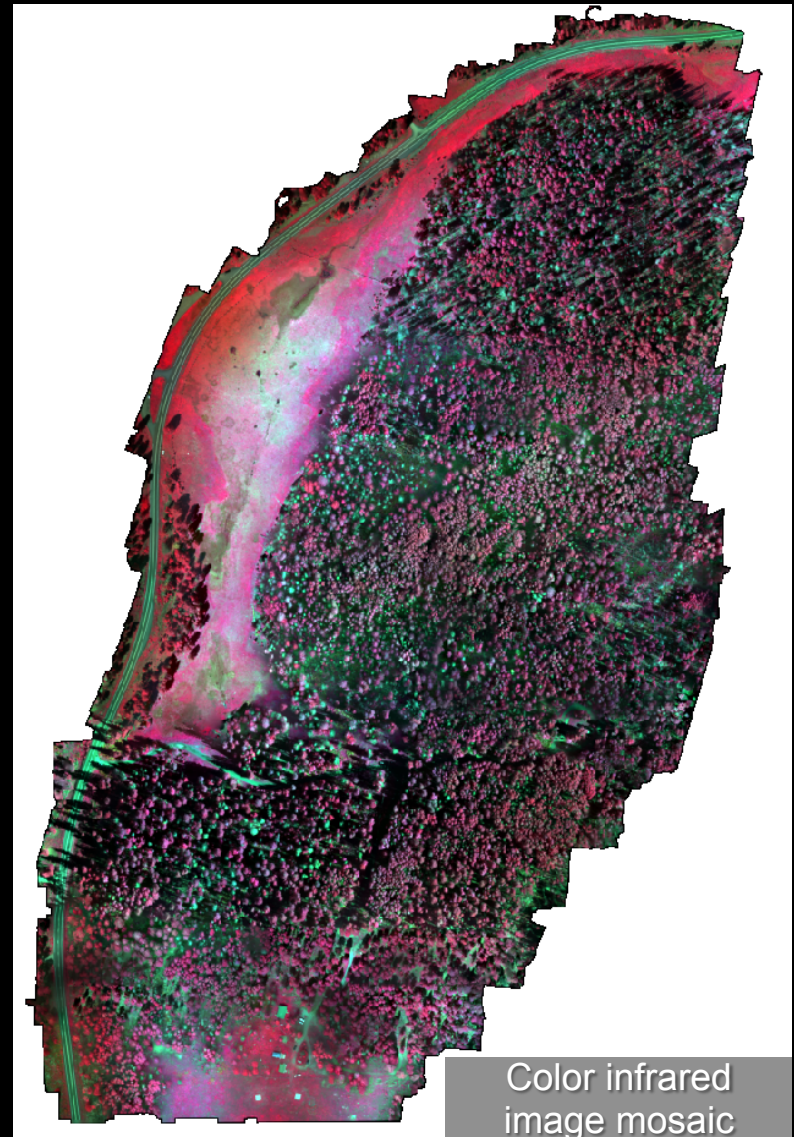
Color infrared image mosaic

FHP/FM Aerial Survey Mission
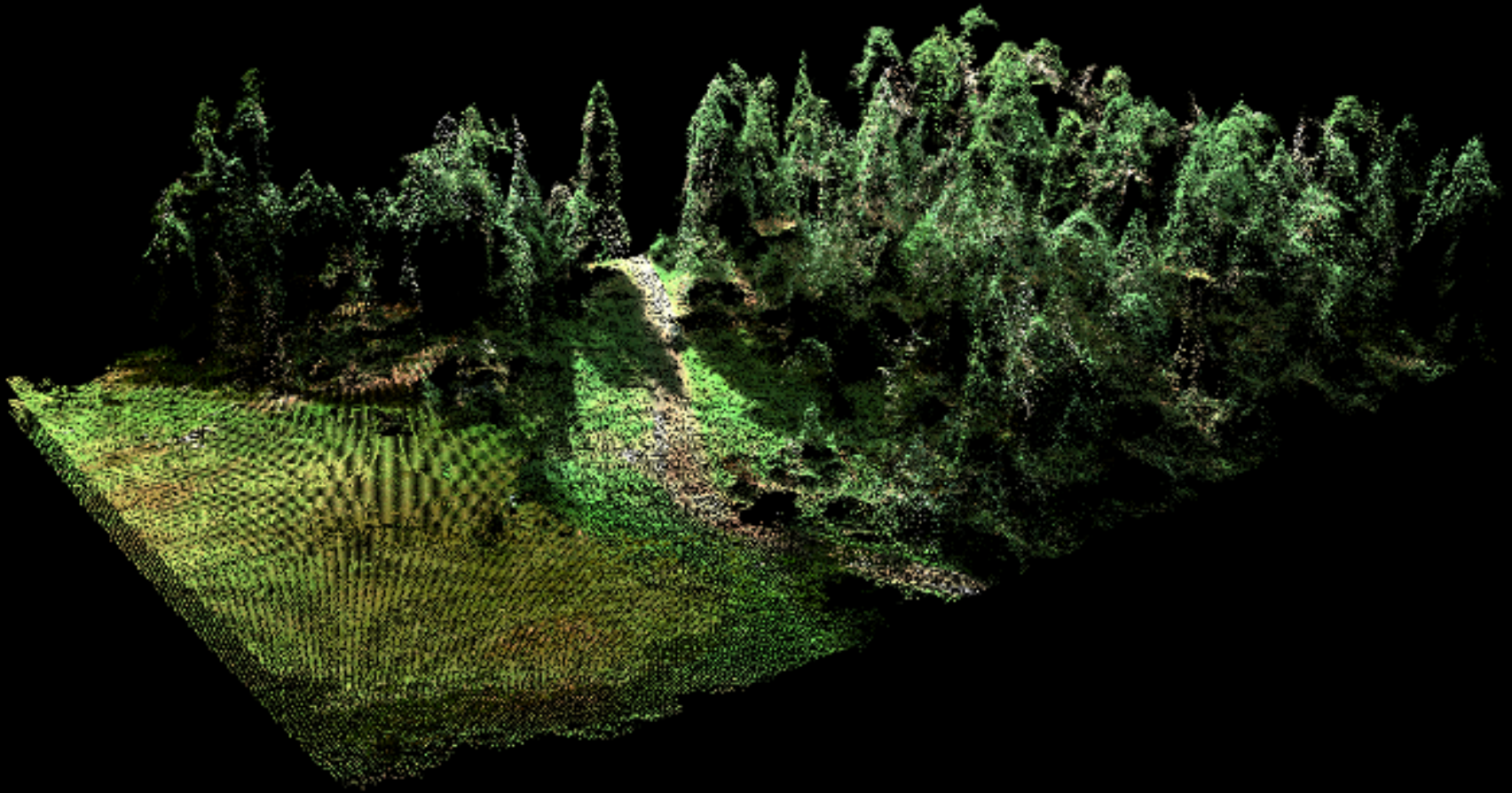
Natural color encoded point cloud

Active Fire Mapping (AFM) Program
(https://fsapps.nwcg.gov/afm)

- Implemented at GTAC in 2001

  - Continuous support by NASA & mission science teams

- Operational near real-time (NRT) satellite data/mapping/visualization products for <u>strategic</u> wildfire management

  - "Value-added" products
  - All lands and ownerships in U.S. and Canada

- Facilitates situational awareness and wildfire decision support

  - Prioritize allocation of suppression assets
  - Focus tactical reconnaissance assets
  - Key data input to several fire-related operational applications
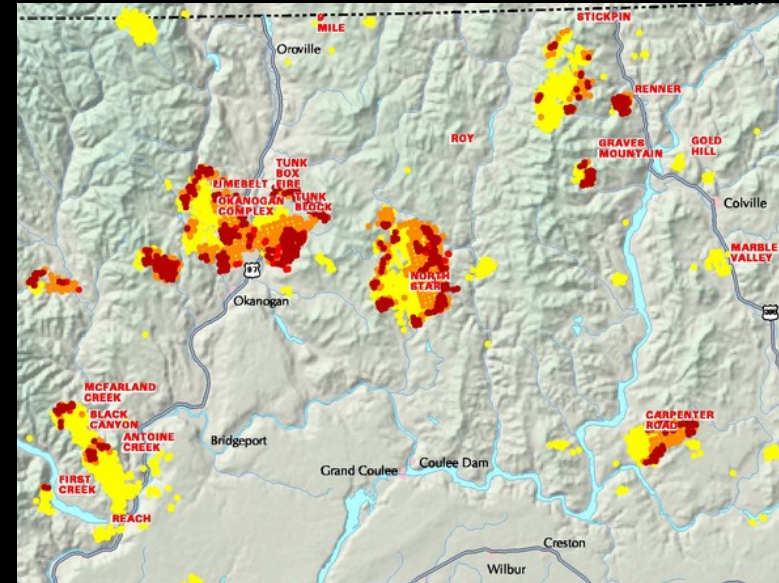
Satellites/Sensors Currently Used by AFM

Relative Ground Swath

GOES Imager 🇺🇸
Fire detection spatial resolution **4000m**
Temporal resolution: **Every 15 min**

> 8000 km swath (entire Earth disk)

S-NPP VIIRS 🇺🇸
Fire detection spatial resolution: **375m and 750m**
Temporal resolution: **Twice daily from one sensor**

3000 km swath

NOAA AVHRR 🇺🇸
Fire detection spatial resolution: **1100m**
Temporal resolution: **6 times daily from 3 sensors**

2700 km swath

Terra/Aqua MODIS 🇺🇸
Fire detection spatial resolution: **1000m**
Temporal resolution: **4 times daily from 2 sensors**

2300 km swath
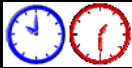
Landsat 8 🇺🇸
Fire detection spatial resolution: **30m**
Temporal resolution: **Once every 16 days**

185 km swath

Geostationary

Morning Orbit

Afternoon Orbit

Emerging Satellites/Sensors of Interest to AFM

Relative Ground Swath

GOES R/S ABI
Fire detection spatial resolution **2000m**
Temporal resolution: **Every 5 min**
> 8000 km swath (entire Earth disk)

JPSS VIIRS
Fire detection spatial resolution: **375m and 750m**
Temporal resolution: **Twice daily from one sensor**
3000 km swath

Sentinel 3A/3B - SLSTR
Fire detection spatial resolution: **1000m**
Temporal resolution: **Once daily from one sensor**
1675 km swath

GCOM-C - SGLI
Fire detection spatial resolution: **500m**
Temporal resolution: **Once every 1-2 days from one sensor**
1400 km swath

Sentinel 2A/2B - MSI
Fire detection spatial resolution: **20m**
Temporal resolution: **Once every 5 days (or less) from 2 sensors**
290 km swath

- GOES-R (GOES 16) launch date: November 2016
- JPSS-1, 2, 3 & 4 launch dates: September 2017, 2021, 2026 and 2031
- Sentinel 3A/3B launch dates: February 2016 and late 2017
- GCOM-C launch dates: 2017, 2018 & 2022
- Sentinel 2A/2B launch dates: June 2015 and mid 2017

Geostationary

Morning Orbit

Afternoon Orbit

Algorithm Research to Operations, Maintenance and Update

International Polar Orbiter Processing Package (IPOPP)

- Autonomous multi-mission, multi-sensor data processing framework
- Plug-and-play execution of Science Processing Algorithms (SPAs), or run stand alone
- Facilitates consistent SPA implementation and easy SPA use/maintenance
- Configurable/scalable to user needs
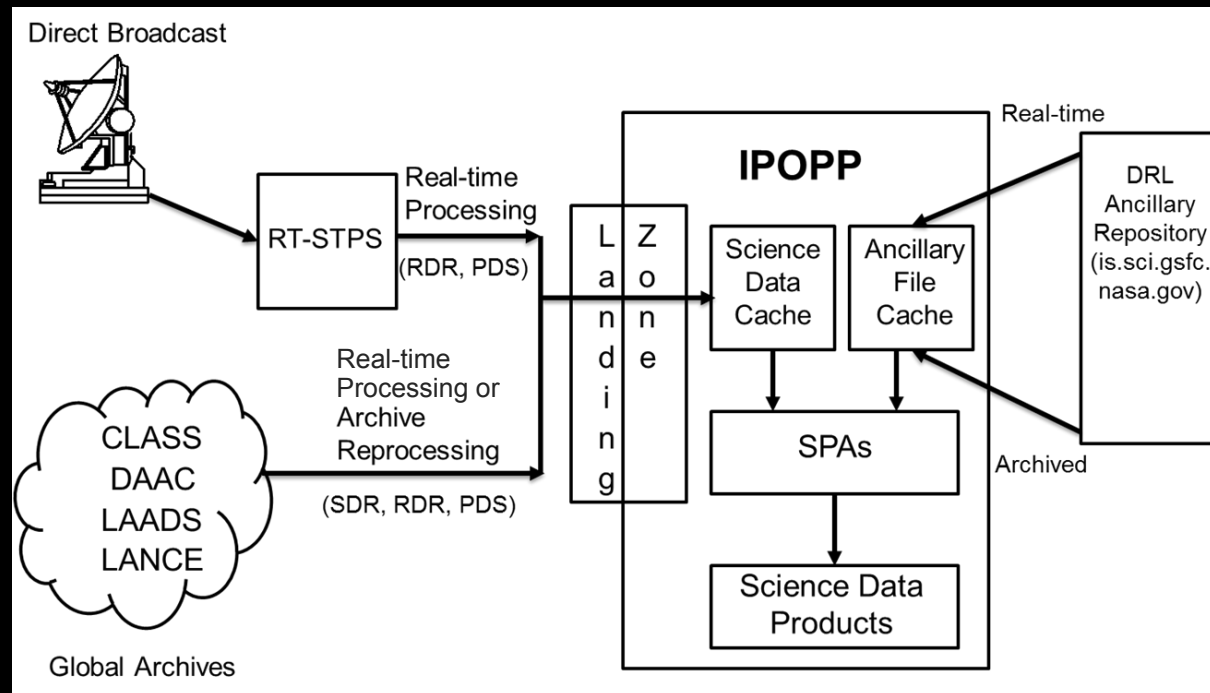
Recent/Ongoing SPA Examples

- VFIRE375
- VIIRS-AF
- MODIS & VIIRS burn scar
- MAIAC
- SMAP soil moisture

GTAC MODIS/VIIRS NRT Data Processing

MODIS/VIIRS Direct Readout Ground Station Network

Low Latency NASA MODIS/ VIIRS Data Stream

LANCE: NASA NEAR REAL-TIME DATA AND IMAGERY

Selected
MODIS L0/L2 & VIIRS RDR/EDR Data
(~30 minutes after acquisition)

L0 & L2/EDR Data (every 15 minutes)

L0/RDR Data

USFS-GTAC IPOPP
Processing System(s)

NASA International Polar Orbiter
Processing Package (IPOPP)

- MODIS L0 -> L1 -> L2 processing

- VIIRS RDR -> SDR -> EDR processing

L2/EDR Product
Stream for U.S.
and Canada
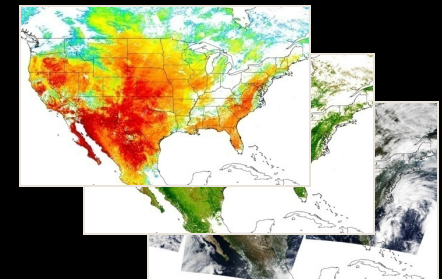
Value-added Mapping/Visualization, Data
& Analysis Products for Dissemination

2016 NASA Direct Readout Conference (NDRC)

- NDRC-9 took place June 21st – 24th, 2016 at Valladolid, Spain

- Host : Laboratorio de Teledeteccion (LATUV) – University of Valladolid

- Sponsors/Organizing Committee*:
  - EUMETSAT* (ITWG)
  - WMO
  - USDA Forest Service* (ILDRCC)
  - Oregon State University* (IDROSC)
  - University of Wisconsin/SSEC* (ITWG)

- Registered Attendees: 180
  - 35 countries represented

- Structured to provide Plenaries and Workshops
  - *Plenaries* for the world to present what they are doing with NASA's data
  - *Workshops* to further enable NASA's data use for decision support systems

- Presentations/Posters/Proceedings
  - https://directreadout.sci.gsfc.nasa.gov/?id=dspContent&cid=244

Burned Area Emergency Response (BAER) Support

(http://www.fs.fed.us/eng/rsac/baer)

- Provide rapid delivery of imagery and derived products to Forest Service BAER teams
  - Conducted on fires exceeding thresholds for size, severity and/or soil resource damage

  - Burned Area Reflectance Classification (BARC), preliminary vegetation burn severity, based on dNBR/dNDVI assessment

  - BAER teams use BARC with field observations and other spatial data to generate a soil burn severity map

  - Soil burn severity map used to target and mitigate hazards to life and property

- All available moderate resolution satellite assets are used

- Imagery and data products available within 24 hours of image availability

BARC

Soil Burn Severity
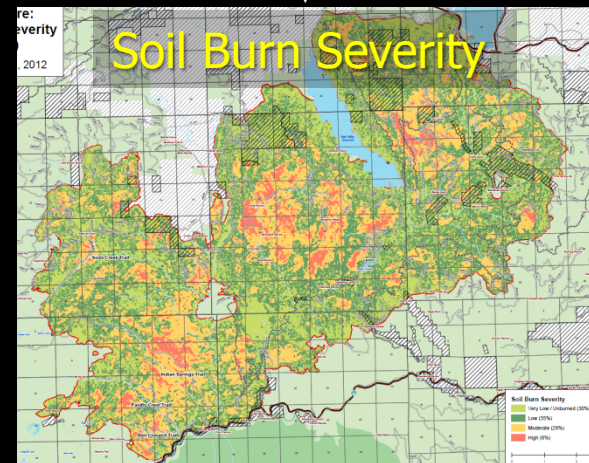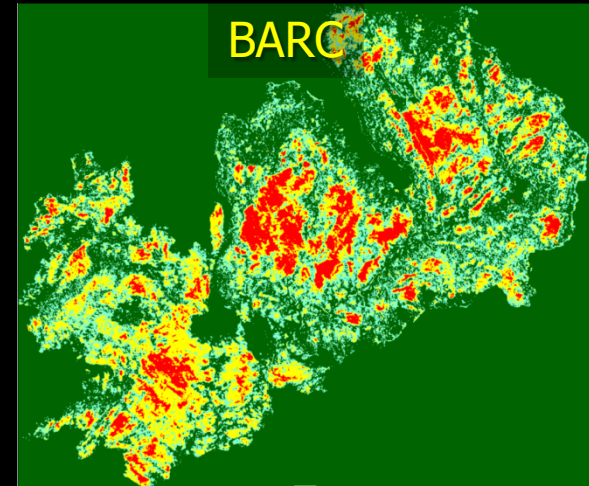
# Burned Area Emergency Response (BAER) Support Updates

- 103 requests completed in CY 2016; 1.1 million acres mapped

- EO-1 mission decommissioned in February 2017
  - ALI imagery no longer available for BAER support

- Sentinel 2A/2B imagery to be integrated when available at suitable latency
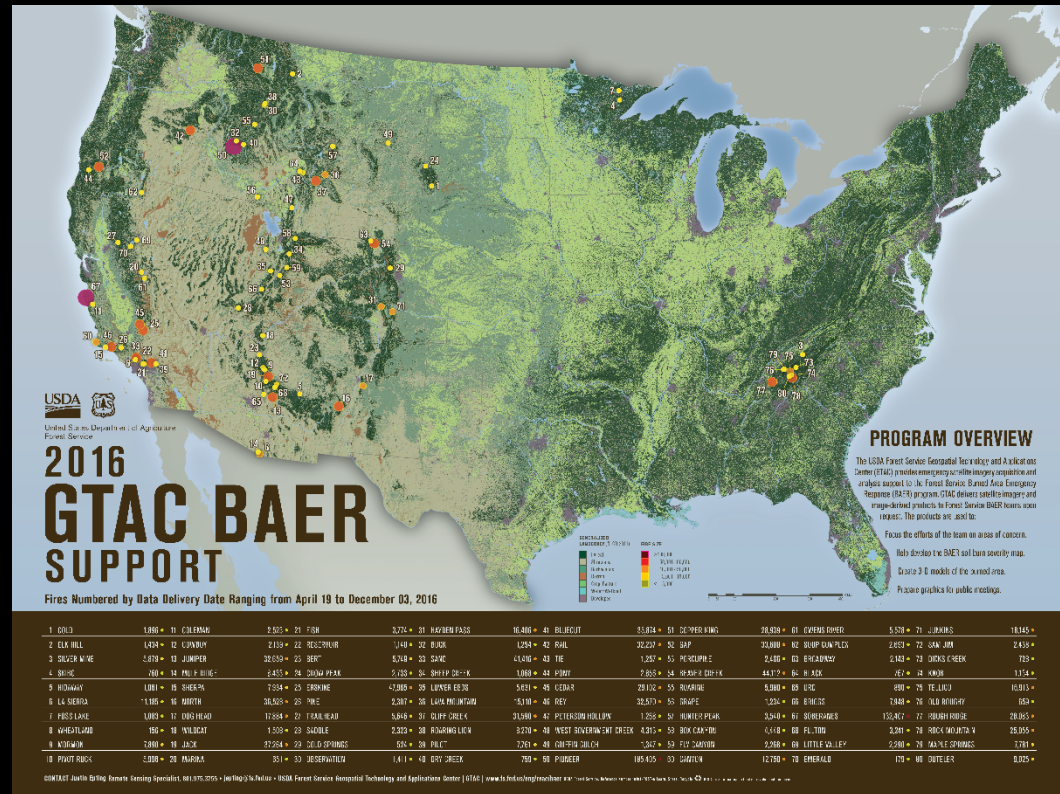
Rapid Assessment of Vegetation Condition after Wildfire (RAVG)
(http://www.fs.fed.us/postfirevegcondition)
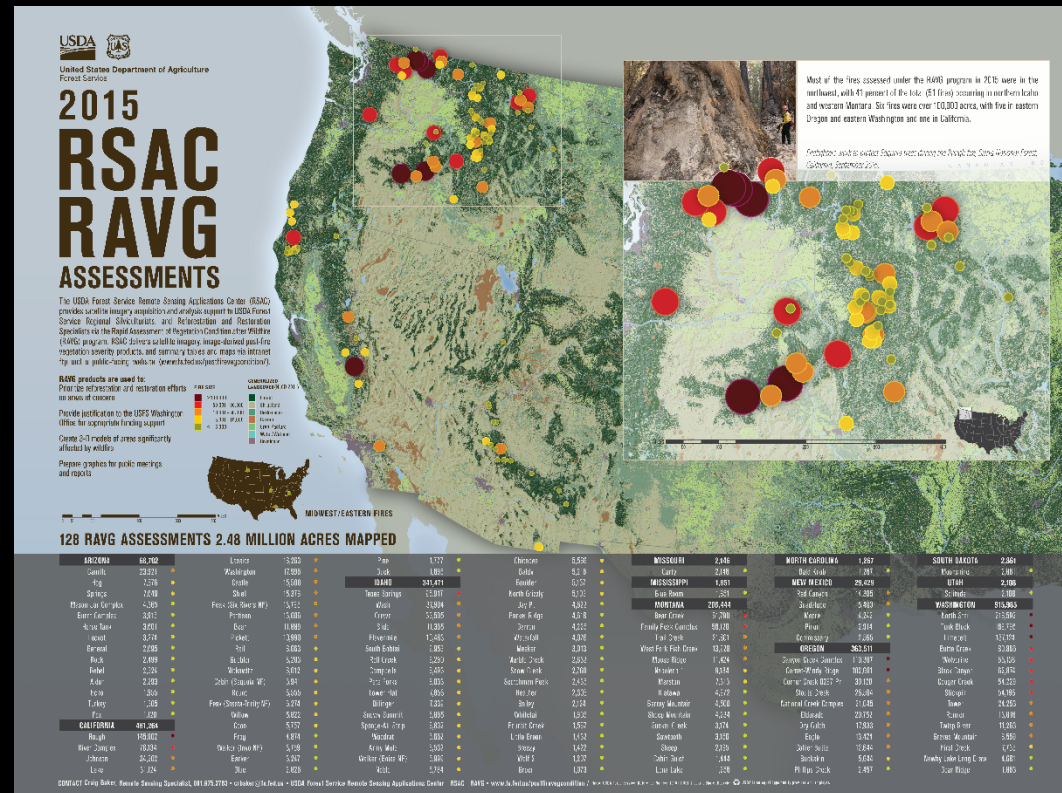
- Provide Landsat imagery and derived products to silviculturists characterizing fire effects on forest resources

  - Conducted on fires where > 1,000 acres NFS forested land cover is affected

  - Assessment based on RdNBR – a variant of dNBR - to derive post-fire forest condition layers

    - Burn severity
    - % basal area loss
    - % canopy cover loss

- Inform post-fire reforestation management and resource prioritization decisions

- Provided ~45 days after fire containment
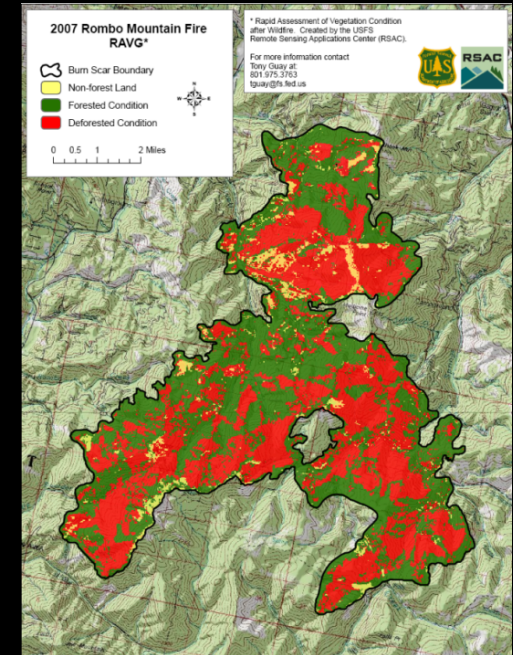
Rapid Assessment of Vegetation Condition after Wildfire (RAVG) Updates

- 100 fires mapped in CY2016 covering > 1.1 million acres

- 14 late season southeast U.S fires yet to be completed

- Threshold change for eastern U.S. fires
  - > 500 acres of NFS forested land cover affected

- Planning to collect additional field data for RAVG models

- Coordination ongoing with USGS to provide RAVG for DOI fires

2016 RAVG assessment poster will be updated when remaining SE U.S. fires are completed

Monitoring Trends in Burn Severity

(http://www.mtbs.gov)

- FS and USGS provide Landsat imagery and derived suite of products for all large fires

  - \> 1,000 acres in western U.S.

  - \> 500 acres in eastern U.S.

  - Post-fire extent and burn severity layers based on dNBR assessment

  - Products are used to support:
    - Assessment of fire/severity trends
    - Assess effectiveness of national fire management policies
    - Land cover product updates
    - Resource management and monitoring activities

- Data record spans from 1984 to present
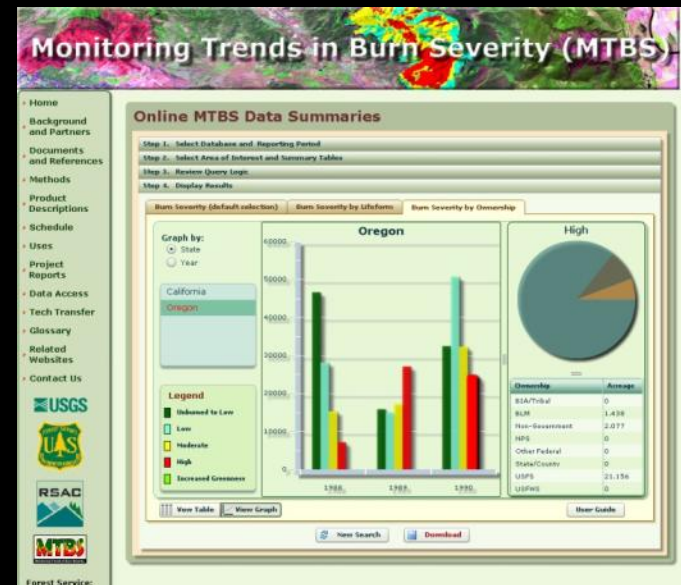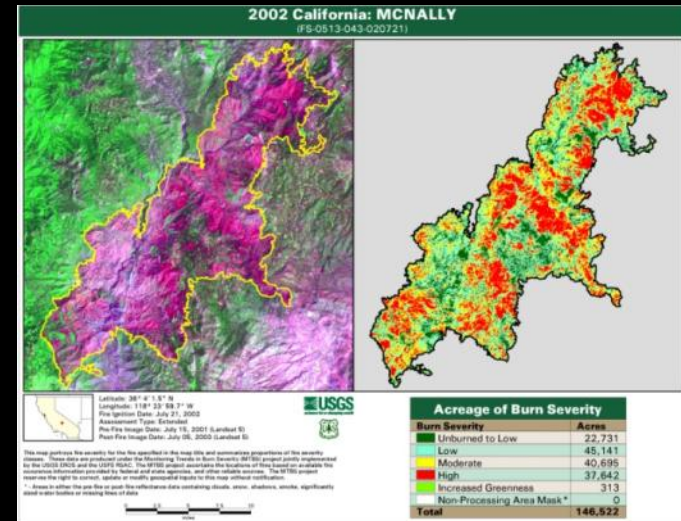
Monitoring Trends in Burn Severity Updates

- Year 2015 fires to be released soon

- Will provide access to > 20,000 fires covering > 155 million acres

- Mapping of additional historical fires recently completed by USGS

- Investigation of new technologies to optimize map production

  - USGS ARD

  - Cloud processing, analysis & computing services

- Evaluation of Sentinel 2A/ 2B imagery for data record continuity

Mapping Status — 1984-2014 (complete), 2015 (in progress). Alaska, Hawaii, Puerto Rico.
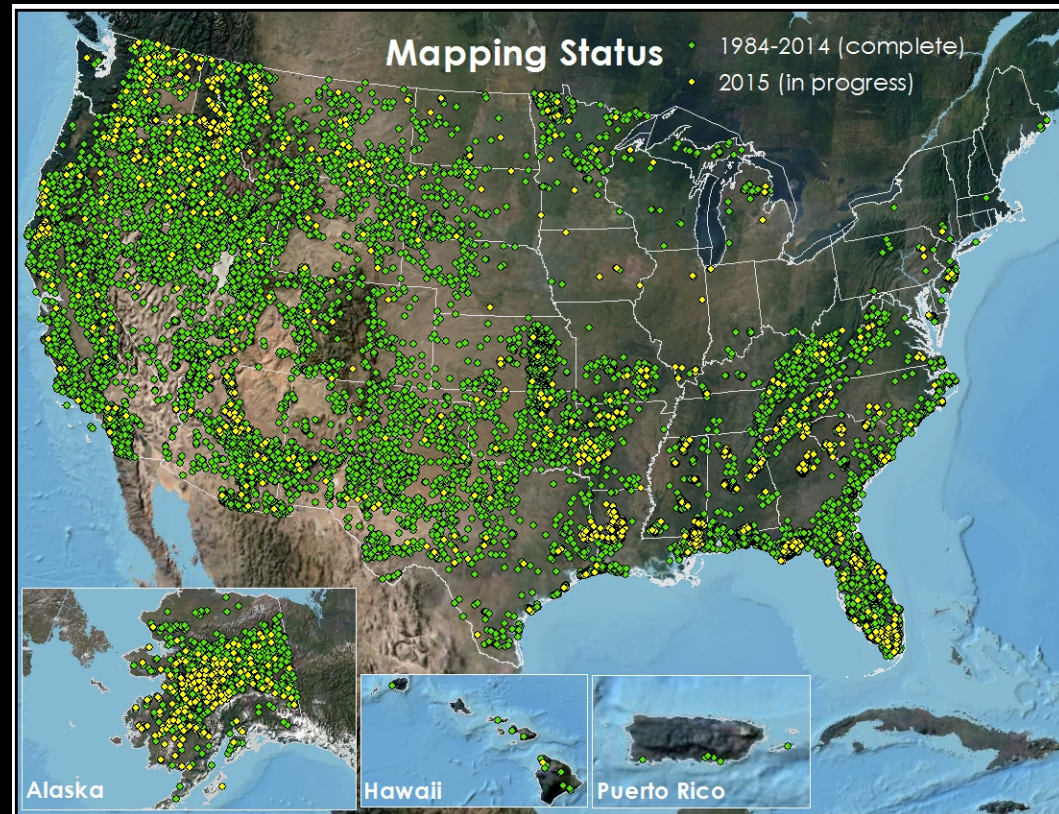
Take Home Message

FS operational wildfire support programs and research to operations initiatives are not possible without NASA support… so thank you NASA!!!

- NASA Goddard Space Flight Center

- NASA Ames Research Center

- NASA Jet Propulsion Laboratory

- NASA Headquarters

Thanks!

Geospatial Technology and Applications Center (GTAC)